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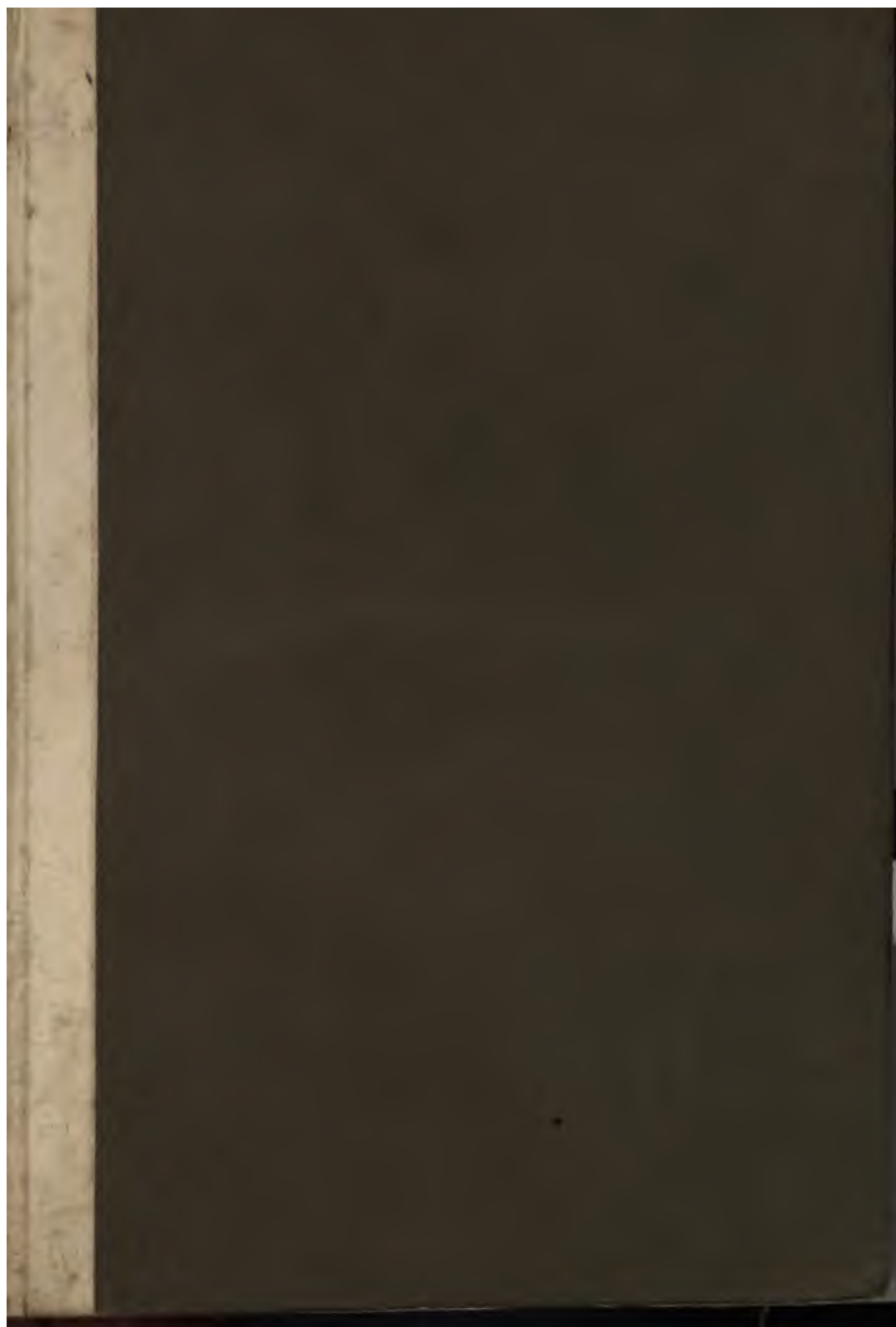
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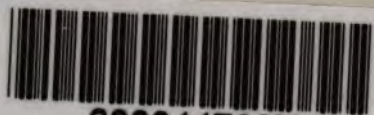
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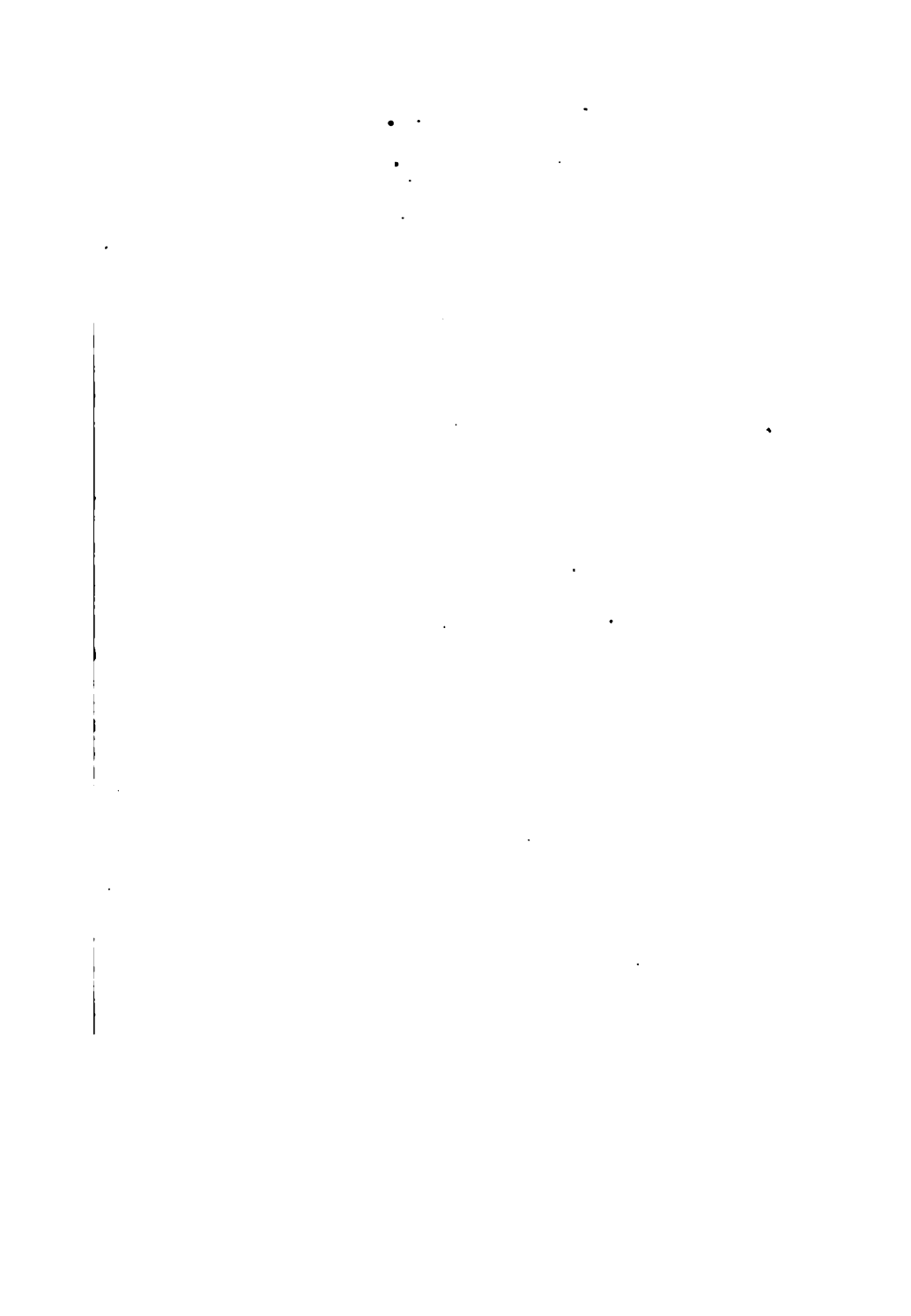
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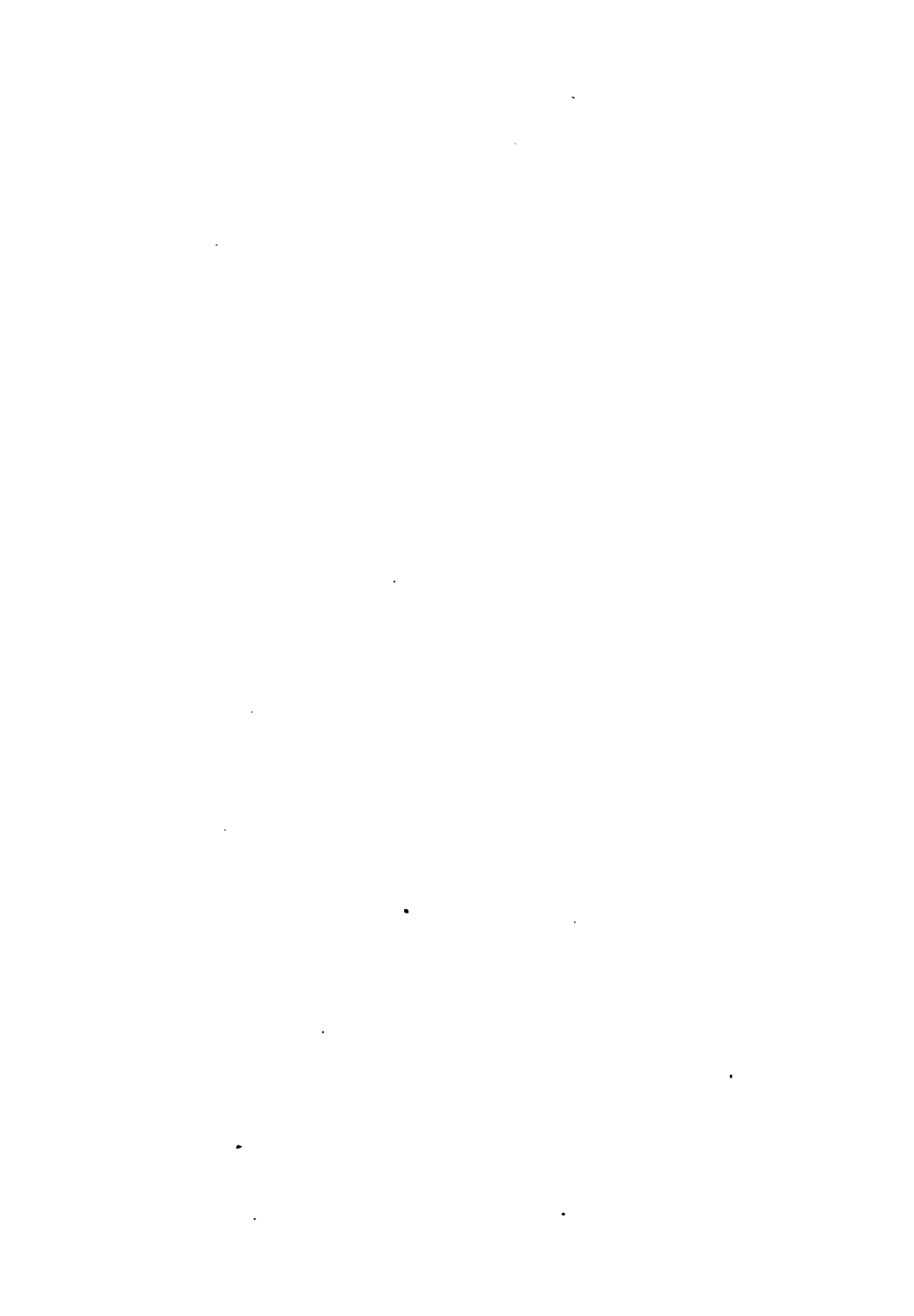


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MISCELLANEOUS PAPERS

ON

SCIENTIFIC SUBJECTS.

BY

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TO
GENERAL SIR HOWARD DOUGLAS, BART.,
G.C.B., G.C.M.G., K.S.C., D.C.L., F.R.S., ETC.,

THE FOLLOWING PAGES ARE,

WITH SENTIMENTS OF

HIGH RESPECT AND ESTEEM,

DEDICATED BY

HIS TREBLY OBLIGED, AND FAITHFUL SERVANT,

THE AUTHOR.

London, April 11th, 1861.

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ON THE CAUSE OF TERRESTRIAL ELECTRICITY, OR MAGNETISM.

As the late President of the Royal Society, Lord Wrottesley, in his penultimate annual address, contained in page 31 of the "Proceedings of the Royal Society," vol. ix., 1859, remarks, that "it is clear that the sun exercises some influence on the earth's magnetism, dependent on the existing state of its own luminous atmosphere;" and again, "that the mild influence of the moon affects the magnetic needle; the declination, the inclination, and the magnetic force all undergo a small variation, dependent on the lunar hour angle;" and also, in his lordship's final annual address, (page 505 *ejusdem*.) "that all the so-called imponderable agents, heat, light, electricity, and magnetism, are intimately connected by mysterious links," I wish to offer a few remarks, which had some time previously occurred to me, upon that most interesting subject, Electricity—a subject which yet occupies, and has continued to occupy, the absorbing attention and persevering inquiries of the first philosophers of Europe.

It being an established and universally well-known fact that Electricity is an agent that is, and can be, easily produced by the effect of friction, such, for instance, as

that which is caused by the rapid and continuous attrition, one against the other, of certain substances, even though they may be the one a conductor, the other a non-conductor of that fluid, it has occurred to me that Electricity, an (as yet) "imponderable agent," is caused or produced on the earth's surface simply by the *friction* created by the sun's minute rays (of light) impinging upon, and thence passing through obliquely (or directly), and with immense velocity, the denser particles (of elastic fluid) constituting the earth's atmosphere; if, indeed, they would not produce a similar, but partial, effect, by striking obliquely, without the intervention of any medium whatever, upon the bare surface of the earth itself.

Now, if this supposition be well-founded, a great portion of the electrical phenomena, as now noticed, may probably, if not certainly, be accounted for—such as the varied and various *maxima* and *minima* of magnetic (electric) inequalities that are observed, whether diurnal or decennial; the sun's *spots*, in the latter case, of course causing, during the periods of their continuance, a considerable, or appreciable difference of amount in the quantities of electricity produced or experienced, as more or less interfering with the otherwise constant transmission of the rays (of his light) in the direction of, or towards this sphere. The effects of the *aurora borealis*, likewise, may be accounted for; and with respect to the variations effected, as it is remarked, by the moon, it is

only necessary to say, that that luminary dispenses her rays in a lesser degree, and with lesser effect, they being reflected by her from the sun itself; and, consequently, with a lesser electric effect.

Now, in support of this theory, which I have presumed to erect, it scarcely seems requisite for me to remark, that the rays of "light" emanating from the sun, however "imponderable" they may as yet have proved, must necessarily have an immense attritional effect (if I may use the term) upon the denser particles composing the earth's atmosphere; because they strike upon the latter with a force directly proportional to their inconceivable, though measurable velocity, sufficient, indeed, when collected, to fuse the hardest metals, and even the diamond itself. Nor does it seem scarcely requisite to notice, that the earth's atmosphere has, or possesses, a proportional power to, in part, resist them (the sun's rays)—as that effect is incontrovertibly evidenced by the fact of the existence of twilight, whereby they only reach us by inflection, which inflection is caused solely by the great resistance of the particles constituting the earth's atmosphere.

It may be observed, also, that whether there were an atmosphere or not circumscribing this planet, an effect similar to, but probably of lesser degree than that now observed, would be occasioned by the oblique incidence of the sun's rays upon the *side* surfaces of the bare earth itself; and, therefore, the moon (should she, as has been

generally supposed, have no atmosphere at all, as is very doubtful, for reasons given at pages 107 *et seq.* of my "Miscellaneous Papers on Scientific Subjects," vol. i., 1837) might also be subject to a similar influence, and might therefore exert that influence on the surface of this globe by transmission of the sun's rays by simple reflection, with a naturally diminished force, and a correspondingly diminished effect.

A thought, more or less important, likewise suggests itself from the above considerations, viz., that, as heat to an intense degree is, or can be, produced by great pressure (as of a steam-hammer, or of revolving rollers), or by attrition (sufficient to set the nave of a rapidly revolving wheel on fire), or by impulse, is it not possible that the heat we experience, or fancy we experience, as coming directly from the sun, is in fact an effect produced by the great force *alone* (?) with which his rays impinge upon, or pass forcibly through, the particles of terrestrial atmosphere, which thereby become heated by the force, velocity, and repetition of the blows, and thus convey the feeling of heat to our sensation? But, whether the rays that reach us from the sun be those of electricity, or those of light, or those of heat; or, whether light be the effect of electricity, which by attrition produces it, or electricity be the effect of light, an effect produced, as I have above endeavoured to show, by the force of impingement of the sun's rays upon the particles of a denser medium, consisting of partly an inflammable

nature, as one (if not two) of its constituents" proves ; or whether, also, heat be not the effect of both the above causes, light and electricity *combined*, one thing is evident, nay, certain, that electricity constitutes the heated and lighted spark of fluid which, as a bright and palpable body, passes through, and makes a visible aperture in, a piece of card-board ; that it, also, by means of the galvanic battery, (Query—Is not galvanism, of a surety, a like ingredient to magnetism ?) ignites the submerged loaded mine ! The conclusion may be arrived at without, possibly, doing violence to our feelings, that there would appear to be but little, if any, difference in, or, if not, the closest affinity between, these "imponderable agents ;" for, light evidently contains heat, and heat mostly contains light, and electricity, is, I assume, the *cause* of both. Indeed, if otherwise, how can we account for the phenomenon of the Indian lighting his fire by the attrition of two sticks of wood ; or, for the combustible being ignited by the blow of the flint upon the steel ?

Feeling therefore, in my own mind, assured that the cause of the existence of electricity upon the earth's surface is the action of the sun's rays upon the earth's atmosphere, I have suggested the consideration of some existing facts, which will, I sincerely trust, lead the scientific inquirer to the conclusion I have arrived at, namely, that the sun's rays, by acting obliquely (or directly), and with great velocity upon the particles

constituting the earth's atmosphere, do thereby produce, by the sole effect of friction upon them, the imponderable agent, termed "*electricity*," and hence, in all probability heat and magnetism, (and *possibly light itself?*) if not the fifth agent, above adverted to, galvanism.—*February 1st, 1860.*



ON THE SUBJECT OF UNIVERSAL GRAVITY.

SUPPOSING the moon to be, by any means whatever, stopped in the course of her mid-career in her orbit round the earth, would she, or could she, as a consequence of the attraction of gravitation, fall into the earth or not?

I deferentially submit my opinion that, under the above-mentioned circumstance, the moon would not, and could not, fall into the earth for the following reasons:—for, suppose the moon, the instant after the stoppage of her course had been effected, to commence falling towards the earth [Note A], as she, of necessity, must do, through the effect of the centripetal force caused by gravity, a certain portion of *time* must necessarily elapse before she could reach that point in space which had

NOTE A.—Is it possible the moon could have ever been a minor planet, revolving round the sun, (like the many smaller planets discovered of late years by Mr. Hinde,) and that, through the eccentricity of its orbit, it could have come within the influence of the earth's attraction so as to have succumbed to the same, and to have thus become detached from the sun's attractive power, excepting by submitting to it in conjunction with the earth?

previously been occupied by the centre of the earth (the point of attraction) at the instant of the stoppage.

But, as the earth is always in a state of progressive motion in the path of its orbit round the sun, so the earth would, by the time the moon would have arrived at the said point in space, have progressed so far away from that point, that the velocity of the moon, now increased more and more by her successive approaches towards the point of her perigee, would cause her to pass beyond that point, and so onwards, until the attraction of gravity of the earth, which from the first moment had never ceased to act, should have gradually affected, or retarded, her centrifugal force, and thus have caused it to, in part, give way—bringing her again towards, or in the then new direction (new as concerns the moon only) which the earth had taken: and so, her velocity again increasing gradually as she again approached the earth, the earth at the same time having, as before, progressed onwards in the path of its orbit round the sun, the moon must necessarily, in her successive endeavours to reach the earth, be obliged, for the reason first given, to pass and re-pass the latter again and again, and so on, doubtless, for ever. And, as she must consequently accompany the earth in its elliptic orbit round the sun, she would necessarily perform her elliptic (or, rather, epicycloidal) motions round the earth, *as she now does*, although their form would then probably be much more elongated than it now is found to be.

Moreover, as the earth's orbit, although an elliptic one, has such little eccentricity as to constitute nearly a circle, an effect still greater would be produced against the direct progress of the moon towards the former than would be the case if the path of the earth were only a straight line. [Note B.] Indeed, in the latter case, the moon would *possibly* (as *perhaps* might be proved) reach, in the course of time, the earth, the divergence in her path on each successive return towards her perigee decreasing successively, until she would have attained the centre.

The main conclusion arrived at in the foregoing remarks applies equally to the affections of the other secondary planets, namely, the moons or satellites of Jupiter [Note C], Saturn, and the Georgium Sidus, and, if this

NOTE B.—And yet the paths of comets more nearly agree with straight lines than those of any other celestial bodies—albeit comets do not fall into the sun, gaseous and diaphanous though their substance seem to be.

NOTE C.—Extract from Hutton's *Mathematical Recreations*, vol. iii., p. 160, 1803. "The fifth (satellite) describes an orbit inclined in an angle of from 17 to 18 degrees to the orbit of Saturn. Dr. Herschel observes that this satellite turns *once round its axis exactly in the time in which it revolves about Saturn; and in this respect resembles our moon.*" And at p. 159, the Doctor says "*It is probable that Saturn has a rotatory motion around his axis; but the best telescopes have not yet shown on his surface any remarkable point by means of which this rotation could be ascertained or determined.*" In my papers on the cause of the moon always presenting the same face to the earth, I have explained it by remarking that the earth's attraction on the nearest point of the moon's surface being (nearly) constant, and greater than on any other part of her surface,

be granted, it would possibly apply also, not only to the whole solar system, but to the systems composing the universe itself, and thus exemplify the protective care and wisdom of that all-powerful Being who placed the different orbs in their respective positions, and endowed them with that all-pervading property of gravitation, which balances and preserves the work of His hands in eternal order, harmony, and duration.

P.S.—I take this opportunity of repeating the expression of an opinion I have elsewhere stated, viz., that the cause of the moon always presenting the same face to the earth may be thus explained. The attractive force of gravity towards the earth exerted upon that part or point of the moon's surface, which is immediately in the line connecting the centres of the earth and moon, is necessarily greater than that exerted upon any part lying on either side of that line, because the latter is more retired, or situated further off, consequently, that part or point of the moon's surface first mentioned must necessarily remain in or upon that line of junction, and as the attraction of gravity is constant, the position must be constant also.—*February 29th, 1860.*

she necessarily has no power to present a different face towards us, and as the earth turns on its orbit, so it may be supposed that Saturn, likewise, turns on his, in order to give the motion to this (fifth) satellite, which it is found to possess; as, no doubt, possess all his other satellites, though as yet unknown.—T. S. B.—*February 13th, 1861.*

ON THE SUPPOSED DISTANCES OF THE FIXED STARS.

It has been concluded by some of the first Astronomers that the very remote bodies called "fixed stars" are constituted of a nature similar to that of the sun—or, in other words, that they are suns like our own—dispensing light and heat of their own, instead of receiving light and heat, as is the case with the planets.

Such astronomers have likewise supposed the distances (or squares of the distances) of these fixed stars to be inversely proportional to their brightness. [Note A.] Whilst others have looked upon them as inversely proportional to their respective magnitudes—"magnitudes differing not materially from that of the sun."

Now, assuming the latter to be quite as reasonable and probable a conjecture as the former, I shall adopt the latter for the purpose of my argument, viz., that wherein the distances of the fixed stars are considered to be in inverse proportion to their respective apparent magnitudes—their real magnitudes differing but little (as it is reasonably conjectured) from that of the sun.

Note A.—To calculate the distances of the fixed stars by the difference of degrees of their brightness seems to be a questionable operation; inasmuch as substances of equal volume may give out light of disproportionate relations—instance that of the Bude light compared with that of a common taper. Besides, the *colour* of some stars differs from that of others—that of Castor and Pollux, for example.

The question now arises, whether, as we know the distance of the sun from the earth to be ninety-five millions of miles, we cannot, upon the data above afforded, determine the approximate distances of these very remote bodies in question—so far, at least, as those of the sixth magnitude, if not those of a lesser degree—now that astronomical observations have of late years been so facilitated by the extraordinary improvements that have been effected in object glasses. [Note B.]

Having, then, assumed, as above, that the bulk or magnitude of any one fixed star is equal to that of the sun, the diameters of the sun and star will be equal also, and it is by making use of these means I propose to measure the distance of that star from the earth.

It will doubtless be allowed that if we could by any means manage to project the *image* of any fixed star (say Sirius) upon the disc of the sun, (a thing not impracticable, as is, I conceive, shown below,) [Note C,] it would be quite possible to measure the proportionate

NOTE B.—For this purpose, could not the *inner circumference* of the object end of the telescope be divided into proportional parts, with which the apparent diameter of an observed star could be *approximately* measured?

NOTE C.—By using an instrument similar in principle or effect to "Sir Howard Douglas's Reflector," the image of the star might be brought over and upon the disc of the sun, moon, or planet—and thus its apparent diameter be actually measured upon the surface of either of those bodies, in parts of the apparent diameters of the same.

surface he occupies of the sun ; or, rather, the proportion his apparent diameter bears to the apparent diameter of the same.

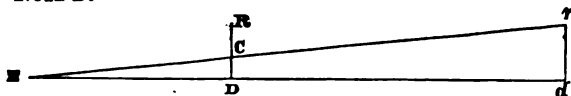
But, as we cannot well notice the stars when the sun is situated above the horizon, it becomes necessary to employ a substitute for him—and as at certain periods of the year the *apparent* diameter of the moon almost exactly coincides (if I mistake not) in measurement with the apparent diameter of the sun (I mean as measured by the eye) projected upon a great circle of infinite space ; so we may advantageously make use of that of the moon.

Now, although it is not easy to project upon the face of the moon the image of any star, it is not impracticable, when any star is in *juxtaposition* with the moon, on the dark side (which though dark is still sufficiently visible, *especially* during an *eclipse*,) to notice and observe by actual instrumental or astronomical measurement the proportional part which the apparent diameter of the star bears to that of the moon. It *must* constitute *some* portion of its length—say, for the sake of easy calculation, one-fiftieth part or one-hundredth part—although, as far as I can judge by the naked eye, one hundred, or even fifty, apparent diameters of the star would, if measured continuously along the apparent diameter of the moon, more than equal the length of the latter—but, as I said before, let one-fiftieth be assumed as the observed proportion.

It will be scarcely necessary for me here to show that

by drawing lines (as in the diagram, Note D,) from the eye of the spectator at the point of observation on the earth's surface, through the two extremities of the apparent diameter of the star to the two extremities of the diameter of a body measuring *apparently* one hundred times, or fifty times *greater*, though *really* of *equal*, diameter, and distant, as is the sun from the earth, ninety-five millions of miles, two similar triangles will be formed, having, therefore, their like sides proportional—whence the diameter

NOTE D.



Let DE represent the *apparent* diameter of the sun, equal also to dr , that of the star, equal to 1.

Let DC be the part of DE , as projected on the sun's disc by the star's image—say, one-fiftieth, or $DC = \frac{DE}{50}$

Draw the line Ed through the extremities of the apparent diameters DC , and dr , and join E , the point of observation, with r , the other end of the star's (or sun's) *apparent* diameter. Then DE being parallel to dr , two similar triangles, EDC , Edr , will be formed—whence the distance Ed will be found.

For $\left\{ \begin{array}{l} DE = dr = 1. \end{array} \right.$

Put $\left\{ \begin{array}{l} DC = \frac{DE}{50} = \frac{1}{50} \end{array} \right.$

$\left\{ \begin{array}{l} DE = 95 \text{ million miles.} \end{array} \right.$

By sim. $\Delta s. DC : DE :: dr : dE$

$\frac{1}{50} : 95 \text{ mm.} :: 1 : \frac{95 \text{ mm.}}{50}$

$= \frac{95 \text{ mm.} \times 50}{1} = Ed = 4,750,000,000 \text{ miles, or distance of star from the}$

earth. Thus, the distance of the star from the sun will be $Ed - DE$

$= Dd = 4,655,000,000 \text{ miles.}$

of the star will be found equal to (100 times or) fifty (50) times that of the former [Note D]; so that if the sun be distant from the earth ninety-five millions of miles, the star will be $95,000,000 \times 50 = 4,750,000,000$ (four thousand seven hundred and fifty millions) of miles distant; or if multiplied by 100 instead of 50, the distance will of course be doubled, or equal to 9,500,000,000 miles. [Note E.]

As the above results appear to differ to an *immense* amount with the present known or supposed distances of any of the fixed stars, I beg most deferentially to bring the circumstance to the notice of the Royal Astronomical Society.—*London, March 1st, 1860.*



ON THE FORMATION OF AËROLITES.

ANY one who has resided at Malta during the autumn of the year must have noticed the occurrence of occasional showers of almost impalpable powder, dust, or sand, which is blown over to the island from the main land of Africa opposite, (a distance, probably, of one hundred and fifty miles,) and deposited on the surface of

NOTE E.—If it be impracticable (which is doubtful) to compare the apparent diameter of the star with that of the moon, it may first be compared with the apparent diameter of any planet when in juxtaposition with it, (and whose apparent diameter is of course known,) and this again with that of the moon—the proportionate length which each bears to the other being successively noted and measured.

the ground to a noticeable height or thickness of layer. It is likewise well known that the atmosphere of any locality whatever, is capable of sustaining very fine particles (like the above) of powder, sand, or common dust (as is shown by the sun-ray in a darkened room, through a crevice in the window-shutter).

Now it will, of course, be conceded that every one of these minute particles of sand, powder, dust, or stone, has as much proportional tendency to gravitate towards any point of attraction as the earth has to gravitate towards the sun; and as I assume that the atmosphere is more or less impregnated with electricity, [which electricity is *generated*, probably, by the *friction* of the solar rays impinging with inconceivable velocity upon the component particles of the air, as described in a former paper of mine on the subject,] some parts of the atmosphere being more impregnated than others—for reasons that may possibly be assigned—so, it must be conceded that some of these dusty particles become also impregnated with electricity; and, consequently, that when one part of the atmosphere containing them acts or attracts with considerable force, in consequence of a greater accumulation of these particles at one place than another, so such particles of dust suspended in the air as are more immediately in proximity to that point of attraction, are attracted with considerable force towards it—so much so, probably, that in the efforts made to reach the common centre of attraction, they rush

together from different or opposite directions, and are so forcibly driven or attracted one particle against another, and with such unimpeded and immense velocity, as on their contact to cohere and form the solid body termed an "aërolite;" or, as the country-people name it, the "thunderbolt"—and which solid has been found to be exceedingly compact and indurated, and in some instances of considerable bulk.

In a similar manner, I deferentially suggest, fiery-meteors may possibly be formed—but, these *phenomena* not having had time to solidify during the very brief period of their formation, (which accords, I presume, with the circumstances assumed in the foregoing description) or, more likely, their component parts consisting of particles much more volatile than those before described—and these volatile parts becoming highly heated in consequence of the great rapidity of their flight through the air—upon the aggregate quantity of these particles reaching the common point or centre of attraction, they are, through the effect of impingement, added to their already overheated, as well as volatile, state, set on fire, and thus compose the brilliant meteor-light displayed at the periods of their occurrence.

The rapid motion in any one direction observable in these meteors is probably generated by the rushing of particles which compose it in greater quantities in one direction than another—the effect of the greater number of course preponderating, and causing it to proceed in

the *resolved* line of their flight *towards* it produced or *continued*, and so as to drive it forcibly onwards in its trajectory, or path, at the termination of which it bursts into a still further illuminated exhalation, in consequence of the intense heat imparted to it by the further combustion of its over-heated particles, as well as by the friction | produced on its surface, and continually added to, in consequence of the rapidity of its flight through the atmosphere.

I take the opportunity of saying, before closing this paper, that it is with extreme diffidence I offer its contents to the notice of the philosopher. The subject, however, being a most interesting one, and, if I err not, still in doubt, I have humbly endeavoured to submit such an explanation of the *phenomena* as has occurred to me.—*December 18th, 1860.*



ON THE FORMATION OF THE SUN AND THE SOLAR SYSTEM.

IN reference to the opinion I have expressed in the above paper, "On the Formation of Aërolites," I suppose it possible, in the first instance, that the whole of that measurement, if measurement can have a name which is measurable only by "the great Architect of the Universe,"

and which is called by us "empty space" and "infinite space," may, previously to the formation of the heavenly bodies, have been filled with, or thoroughly pervaded by, the very atoms of matter that now compose the bodies or masses of ponderous substance constituting the bulks of the "sun, moon, and stars"; but, atoms of such extreme tenuity as to have originally formed a medium consisting of particles quite imponderable, and probably of very much lesser density than that of the "very thin and slender vapours" which have been conjectured (by Sir Isaac Newton) to form the *coma* of comets, and yet this "very thin and slender vapour," or *coma*, must necessarily be governed by the force of gravity; or, in other words, it must contain within itself the essence of gravity, which is nothing more or less than what we term "weight"—for otherwise it would quit the vicinity of the *nucleus*, and dissipate in "infinite space."

Secondly, I suppose it possible that portions of this impalpable matter, so volatile, and occupying immensity of space, may, by any means, of gravity or of electricity, primarily existing, or of attraction inherent in it—either or all of these forces being imparted by the Supreme Being—have gradually formed, by the constant addition of adjacent particles, particles of a correspondingly condensed nature, which, in their turn, attracted others lying nearer *them*, until some of the preponderating particles, overcoming the attraction of others, drew or attracted towards themselves greater numbers of particles than

others drew—until a larger, a gradually denser, and finally, a more solid body was formed. In such manner the formation, according to the “original design,” of the heavenly bodies may possibly be understood: and, also, that as there cannot be “two suns in the same firmament,” the larger controlling the effect of the lesser, so only one sun exists in the system of which the earth forms a part, to control the lesser orbs which complete it—the sun attracting the most powerfully all the minor bodies towards it, and likewise extracting all their lesser lights from their surfaces, and appropriating them to its own use—and again dispensing them afterwards in currents of light, and heat, and electricity (or magnetism,) to the other bodies, which, as recipients of that light, as exemplified in the planets, satellites, moon, etc., only show or display it by reflection.

I therefore also assume that, as light was created by the Supreme Being, so it also by the same means existed, to a more minute degree, in every particle of existing (created) matter—but that until those particles had been, by the effects before spoken of, gathered together in larger or lesser quantities, they did not possess the power of dispensation, or exhalation, or reflection (of light) any more than—that is to say, to a greater degree than—or even so much as, the vapours of the *coma* or comet’s tail have the power of reflecting light. We all know how little that power is, but still it is apparent, and acknowledged to exist.

Now, as each mass or body of particles formed, by the power given them of tending towards one another, continued to exert its influence upon those bodies situated more immediately near, so some of these bodies attracted the nearer ones more strongly than they attracted others more distant, and thus larger as well as lesser orbs were formed (of lesser density at first, of greater afterwards, the latter being produced by additional and gradual pressure)—by the concurrence of particles, through the effect of attraction (or of electricity) as before noticed—and as all these bodies are necessarily, from the effects of the various attractions, (greater on some sides, lesser on others,) in a state of motion—so it happened at last, I assume, that when the lesser bodies arrived at the point in space of the mass originally possessing the greater power of attraction, the latter body or mass of bodies which *had* attracted them, and still continued to attract them, was discovered to have departed from its place, in progress towards some other point of attraction greater than its own—and so the course of the former became necessarily altered, and they had to follow the latter as soon as (or before) they could reach the point in space before occupied by its *centre*—by this time, however, it had again progressed, through the cause before explained, and the other bodies had to follow as before, and as this motion and attraction would continue for ever, so the circular or rather elongated, or elliptical, as well as epicycloidal, motions would be generated—by which

means the heavenly bodies formed of those originally minute particles floating in (what? ether? *called*) "empty space" (!) would continue their now regular orbits for ever and ever. [On this subject I have elsewhere treated in a paper on the question formerly put, as to "the possibility of the moon falling to the earth."]

On the ground of the former part of this argument, may we not assume it to be possible that *comets* are bodies in a state of transmutation from a consistency of the more volatile particles of matter to that of a denser body—as of a planet, for instance—for, when a comet shall have received additional and denser matter, in consequence of its prolonged passage through immensity of space, it would of necessity become heavier, denser, and more solid—but such a transmutation to the state of a planet might require a lapse of years, of ages, of æons, to complete it.—*January 4th, 1861.*



ON THE CAUSE OF THE ROTATION OF THE EARTH ON ITS AXIS.

I THINK it will readily be allowed, notwithstanding the diversity of opinion displayed in the curious discussion which took place a year or two ago on the

subject in the London journals, that the moon, in performing her monthly revolution round the earth in a period of $29\frac{1}{2}$ days, must, unless she present a different side to us at different times, which is known *not* to be the case, revolve once upon her axis during that period ; so that, having been put into axial motion—or turning upon her axis—she has at the end of the month acquired a rotatory motion, which she would, of course, continue for ever, unless that motion were disturbed by any extraneous cause. But, supposing her, for a short period, to have the power, through her centrifugal force, of leaving the limits of the earth's attraction, if it were possible, would she not *continue* to turn upon her axis as before, once in every $29\frac{1}{2}$ days ? An affirmative reply must doubtless be conceded to this query ; and so she would simply perform a revolution on her axis similar to that which is found to exist in all the other heavenly bodies *known* to us. Those bodies, therefore, by a parity of reasoning, may be conceived to have attained a rotatory motion on their axes by somewhat similar means—saving that these other bodies—such as the earth and the planets—have been caused to rotate on their axes by the influence of the sun, and the sun, again, upon *his* axis through the influence of some other more powerful body unknown to us—and the solar system naturally following with him, in like manner as the moon follows with the earth in its annual orbit round the sun. Thus, possibly other systems of suns may be

supposed to revolve upon their axes round another more influential system—and so on *ad infinitum*.

It will doubtless be allowed, that if the moon performed her orbit round the earth in a circle (not an ellipse, or epicycloid, as is the case) her motion (omitting the effect of the *sun's* attraction) would be uniform—but as its orbit is elliptical (or epicycloidal) the force of attraction of the earth is so greatly increased as the moon approaches its perigee that it overcomes the increased degree of rotatory velocity which the moon would otherwise have acquired in progress towards, and just before quitting, her perigee, and her momentum would have been such as at that period to have caused her to continue her axial motion at the increased rate or velocity she had then acquired. Were it not for this greatly increased force of attraction exerted *retardively* by the earth at this period of lunar propinquity, I would observe that on the moon passing *beyond* her perigee she would, in consequence of the increased velocity and momentum with which she is then moving in her orbit, *and likewise revolving*, be caused to turn on her axis at a more rapid rate than only once in the period of a month—but that such a tendency to do so is held in check—that is to say, prevented—by the power of the earth's increased attraction upon her nearest point.

And may it not, consequently, be supposed that such may be the cause (under like consideration) of the rotatory, or axial, motion of the other heavenly bodies,

differing more or less as it does in all of them?—the discrepancy, however, in every case admitting, possibly, of explanation—whether in consequence of difference of bulk, or of density, or of distance from the sun?

Thus Jupiter completes a revolution on his axis in so many hours (about 10), Mars in so many (about $24\frac{1}{2}$), Saturn in so many (about $10\frac{1}{4}$), each differing from the other. Suppose, on the foregoing hypothesis, that when Saturn (first?) reached his perihelion, he was (for the reason before assigned as to the cause of the moon's rotation) revolving on his axis at a rate only equal to that which would have caused him to perform *one* revolution on his axis during the period of his revolution round the sun (viz., in about 30 years)—because of his being, through the attraction of that luminary, (like that of the moon by the earth,) compelled always to present the same side (or face) to the sun; but, as soon as Saturn left his then perihelion, with, of course, increased *momentum*—the sun's attraction becoming less and less as the former retired (in the course of his orbit), the velocity with which he would continue to turn on his axis would be uniformly increased, and he would, therefore, not continue to present precisely the same face or side to the sun—that is, his *rotatory* motion being now less disturbed by the lessening attraction of the sun, would, in consequence of *its increased momentum*, be uniformly accelerated until he reached his *upper* (I will term it) point of mean distance, when it would have

attained its maximum, or, rather, constant rate of rotation for that one revolution round the sun—from which it would not differ much either on his further progress towards aphelion, or until, on his return towards his perihelion, he reached his *lower* point of mean distance—because the sun's attraction would scarcely be sufficient to cause an alteration in his (Saturn's) rate of *rotation*, after it had once been imparted, until he arrived at his perihelion again—(when it would again be increased, as before ?)—differing so far as respects the attraction of the earth acting on the moon, as that the latter bodies being situated much nearer the one to the other than the sun and Saturn, they would necessarily be more affected than the sun and Saturn in respect of their several and different rates of attraction. In one (the moon) the tendency to increased *rotatory* velocity being overcome by the greater comparative attraction of the earth—in the other (Saturn) that tendency being less, inasmuch as his distance from the sun is comparatively so immense as to interfere more powerfully with the *retardive* effect the sun's attraction would otherwise produce on his axial rotation.

I regret how far it is out of my power to enter more fully upon this difficult, yet most interesting, subject ; I only offer the idea (contained in the foregoing remarks) for the consideration of those who are learned in the sublime science of astronomy, and perhaps capable of elucidating its mysteries.—*December 24th, 1860.*

ON THE SPIRAL OF ELECTRICITY.

THE Vice-President and Treasurer of the Royal Society—in reference to a remark contained in the second volume of my “Papers,” to the effect that “the magnetic needle is never at rest unless in the direction of the North Pole”—having kindly reminded me of the fact of the magnetic direction differing at different places of observation, I wish to offer a suggestion which may possibly serve to explain this apparent anomaly.

I find at page 126 of “Keith’s View of the Heavens, 1811,” the following notice of the *Aurora Borealis*, or *Northern Lights*. “It has been proved by experiments that, whatever is lighter, or swims on a fluid which revolves on an axis, is urged towards the extreme points of that axis : * hence, these inflammable particles continually accumulate at the poles, and by meeting with heterogeneous matter take fire, and cause those luminous appearances frequently seen towards the polar regions.”† Now, having, in my Paper “On the Cause of Terrestrial Electricity,” shown, or endeavoured to show, that this subtile fluid, electricity, arises, or is produced, by the effect of friction of the solar rays upon the fluid constituting the earth’s atmosphere ; and, in the above mentioned extract, the same subtile element (?) or fluid, electricity, having

* See Phil. Trans. (Irish) for 1788, p. 70, etc.

† See Cook’s Second Voyage towards S. Pole, February 17, 1773.

been "proved by experiments" (?) to travel towards the poles of the earth, the two circumstances obviously suggest a consideration whether electricity does not proceed, not only in a direct line towards the north or the south pole, from certain places on the earth's surface, but also whether it does not, from other places, take a diagonal, or loxodromic, or *spiral* course towards the same poles—that course being the effect of a combined action or impulse caused by the earth's rotation on its axis, and the tendency of electricity to seek the pole, either on the surface, or along the axis, of the earth.

This suggestion might be tested, by those who may feel an interest in the subject, by a comparison of the different tabulated angles of the magnetic direction or current, with the relative position of the corresponding localities of observation.—*February 17th, 1861.**

Whilst on the subject of electricity, I may as well submit the following—

NOTE ON THE FORMATION OF ICELAND AND ITS GEYSERS.

It may be conjectured that this island was, in the first instance, raised from the bottom of the sea through the sole effect of electricity, which, travelling with immense

* See Note at end, p. 52.

velocity in a spiral course along the earth's axis, or surface, and accumulating at, the North Pole, so acted as to cause great heat to concentrate, and expand the submerged land in those regions, which land thus necessarily forced its way to the surface of the sea in many jets, and consequent elevations—the Island of Iceland being the effect of the latter action, the Geysers of the former.—*February 17th, 1861.*



ON THE CAUSE OF FAILURE OF THE ATLANTIC CABLE.

MY LORD,

The interest that has been taken, and the aid rendered, by Her Majesty's Government in furtherance of the communication with Her Majesty's dominions in America, by means of the Submarine Electric Telegraph, make it my imperative duty to trouble your Lordship with a few remarks explanatory of the true and sole cause of failure of the Atlantic cable the year before last; which, although it had been so efficiently laid down by the scientific men on board the *Agamemnon* on the one side and the *Niagara* on the other, as to connect the two distant lands, so immediately and irremediably failed.

In order to render the subject of my argument quite clear to your Lordship, and with a view to meet any antagonistic statement that might otherwise be offered

thereon, I shall first copy the subjoined extract from the "Times" newspaper of the 13th of May, 1858, as it serves to explain the manner in which the two half cables were joined—together with the reasons of their being so joined, and which reasons I shall proceed to show, constitute the means I have of explaining the cause of failure.

"To overcome the difficulty caused by the two portions of the cable having their 'lay' or twist of the outside spiral wires turning in different directions, and forming right and left hand screws, the splice will be secured to rods of iron loaded with a weight in the centre; in fact, an apparatus of the same kind as that by which railway carriages are coupled together. By this means the tendency of the different spirals to untwist each other will be overcome."

It thus appears, as well as was elsewhere explained in the "Times," that one half the length of this stupendous mass of cable had been constructed with the (outer) wires twisted in one direction, whilst the other half length was twisted the contrary way—and so that, had the two half cables thus twisted contrariwise been joined together in the usual mode of junction, they would, on simultaneous release, have commenced *de se* to untwist each other, as a necessary consequence of their faulty construction—faulty only inasmuch as regards the different direction of twist given the two portions of cable. But, in order to obviate this positive and existing fault—dis-

covered, however, not too late to have been remedied—for, assuredly one half the cable might have been untwisted and correctly re-made with a twist corresponding with that of the other—it was determined to join the ends of the two half cables, which were intended to meet (and did meet) in mid-channel, to long and strong rods of bars of iron intervening between these two differently twisted lengths—by which means, it was supposed, no ill effects would ensue. Thus the “Times,” June 7, 1858, says of the experimental trials previously made in the Bay of Biscay, and which doubtless served as models for the actual performance,—

“The experiments commenced by forming the splice between the waste coils. The splice is made in a kind of wooden half moon, some fifteen (15) feet long, and rather broad and thick towards the centre. In this, deep grooves are cut, in which the cable is laid, each end passing in at the arms round two eyes in the centre of the crescent, and out at the sides, where the actual joining is made. By this ingenious method the strain of the splice is confined entirely to the ends inside the half moon, (?) while, on the actual junction of the cable outside, no tension of any kind can come. In order to keep the cable ends in their place around the blocks and within the grooves, a strip of boiler plate of the same size as the wooden frame is bolted on to it, while to prevent the two portions of cables untwisting, and to sink it rapidly, a heavy weight is attached to the centre.”

This method of junction having then been determined on, it was, it appears, confidently expected that the two half cables so joined would, notwithstanding the existence of a contrary *helix*, have, in consequence of the intervention of the bar or block of iron between them, no more tendency to untwist each other in that case than they would if joined or fixed to an immoveable mass of granite rock lying in mid-Atlantic. But, if it be considered for one moment by any scientific man, or any body of engineers, that unless the bar or rod of iron situated between the points or ends of the cables were so ponderous as to oppose a force and weight quite irresistible to the constant and enormous tension applied to it by the two half cables, not only in a longitudinal, but in a lateral direction—that is, in a direction tending to turn it over and over on its axis—it would, as soon as the force of the two half cables had been so sufficiently exerted upon it as to act upon its dead weight and friction at the bottom of the sea, (which opposing forces could be but little, compared with the immense strain acting upon it of the two chains,) be caused to turn over and over in the direction of the common strain of both halves, now acting laterally only as one chain in that direction, and as this immense force would and did continue to act upon the block or rod of iron for a given time, it is evident the rod would and did continue to overturn for a corresponding given time, and that the two lengths of cable would and did, in consequence of their

contrary flexure, continue to turn over and over with it in one and the same direction—that is, of their conjoint axis, and so to untwist or unwind each the other.

Should any one doubt the correctness of the opinion I have above expressed, he has only to take in his hands a few pieces of fine wire, cord, or thread, and twist these threads in one direction—say to the right—and so to form a minute cable; then to take an equal number of lengths and twist them the contrary way to the former, or to the left. Then to join the two ends together by a knot or knots, or he can join one end of each half minute cable of threads to a pencil or other light substance, proportional in weight to the former, but of any shape whatever, flat, circular, semi-circular, or otherwise; and if now the centre, containing the connecting piece or “half moon,” be let go, and the further ends of the two twisted cords be tightened by tension, the pencil or central weight will be found to turn over and over upon its axis, and both the little cables will simultaneously do the same—namely, turn over and over both in one direction; so as thereby to become untwisted, and leave but little or no support whatever to the core or axis of the wire, which will then of necessity become gradually distended until its tenuity admit of no further extension, and it will finally become broken and disconnected.

The result of the arrangement above described was nothing more or less than a gradual derangement of the whole line of telegraphic communication almost.

as soon as (some persons said *before*) the further ends of the wire had been attached to the shores of the two countries they were intended electrically or magnetically to have connected.

It matters not that experiments were previously made in the Bay of Biscay for the purpose of proving the method of splicing the two cables to be correct; because those experiments were *not* made by the two ships with portions of the *said* two differently twisted cables, but each ship was provided with "some twenty (20) miles of coil which had been condemned as worthless by the Company's Engineers." ("Times," June 10, 1858.)—And again, "the piece with which the experiments are made, is a portion of the coil lost in the attempt of last year, and which was so injured in hauling up from 1000 fathoms as to become, electrically speaking, of no further use." ("Times," May 31, 1858.)

I trust, therefore, before any more money is laid out uselessly for the purpose of fishing up and repairing, for the object originally in view, the shore ends of the double cable in question, the *central* or rather *junction* portions of which *are*, I assert, *untwisted* and the *core broken*, that I may be permitted to point out how futile would be the labour, how useless the expenditure, should such an outlay took place on this visionary object. For it may, with every appearance of truth, be asserted that the whole cost of labor in making as well as laying the Submarine Atlantic Cable has been absolutely thrown

away—simply because one half of the coil had been manufactured with the twist of the wires in one direction and that of the other half in the other.

In the above remarks I disclaim any other object in bringing the subject to your Lordship's notice than a scientific one, and I have now only to express a sanguine hope that this grand international undertaking may be again commenced and carried through in a manner precisely similar to the first, with the exception of having the cable uniformly twisted—for the contrary method, which was adopted, I assume to have been the true and sole cause of failure of the great operation in question.

I have the honor to be, my Lord,

Your Lordship's most obedient humble servant,

T. S. BURT, F.R.S.

Regent's Park, July 23rd, 1860.

The Right Honble.

The Lord Viscount Palmerston, G.C.B

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PASSENGERS' STOPPAGE SIGNALS.

To the Editor of the Railway Times.

SIR,—Should you approve of the following suggestion (which has long since occurred to me) for removing, to a considerable extent, the difficulty still existing in the conveyance of signals from the passengers of a railway

carriage to the guard, and consequently to the driver of the engine, perhaps you will favour me by giving it a place in the columns of your paper.

Every passenger carriage to be fitted with a simple telegraph, consisting of a moveable brass or iron cylindrical rod, running in a groove at each corner of each compartment of the carriage, and made to pass freely through the roof; and having at its upper extremity a flat, oblong, or semicircularly-shaped piece of board, painted white—the latter forming the noticeable signal; and at its lower end a handle, to be used for the purpose of hoisting or lowering the same.

When a passenger desires to make a signal for the stoppage of the train to the driver, or, rather, in the first instance, to the guard, he has only to raise the rod to the height of, say, one foot, when the board will be observed by the guard (who is to be on the constant watch), the signal be immediately communicated by him, *viva voce*, to the driver, and an instant afterwards the breaks can be applied, the steam shut off, and the train stopped at the earliest practicable moment.

The place of the guard must, of course, be near that of the driver, and a penalty should attach to any one giving the signal without sufficient cause.

The foregoing suggestion could be most efficiently acted on during the day time; but by night the signal-board (which must be placed to the rear of the carriage lamp-light) would, in addition to its being raised, have to be

turned diagonally, as well towards the light extruding through the roof (either by reflection, or directly), as towards the guard in front—one movement, however, of the handle to the right, or to the left, as its situation in the carriage demanded, being adequate to the purpose. Or better still, perhaps, the signal-board might be formed of two plane surfaces, joined together at such a re-entering or inward angle as would be conducive to a proper bearing towards the light and the guard respectively.

(Signed) STOPPAGE SIGNAL.

January 1st, 1861.

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METHOD OF MEASURING THE DISTANCE OF A COLUMN OF INFANTRY.

NOTICING two evenings since some of the City Rifle Brigade in the Regent's Park, engaged in computing and measuring distances, with a view to future rifle practice—a method occurred to me which I have adopted in taking heights, and measuring lengths, of buildings, etc., in sketching objects from nature.

It is this. To measure the *distance* of a column of infantry or cavalry, by the height subtended by the same upon a common wooden pencil, which every rifleman should have in his pocket—and it may be thus performed.

With the pencil held vertically between the thumb and fore-finger of the (right) hand, stretch out the arm to

a horizontal position (or otherwise, as the case may be) to the exact *right* of your own front, which should be at right angles to the column whose distance is required to be measured. Then measure along the upper length of the pencil, by means of the thumb-nail and the eye, the height subtended by the object—in parts of an inch, for instance—or other convenient proportion into which it may have been *previously* divided; so as to allow a certain length of the pencil, when kept vertically at arm's length, as before described, to represent the exact measure of so many yards—*suppose* one-eighth ($\frac{1}{8}$ th) of an inch for a thousand (1000) yards distance. In this case a quarter ($\frac{1}{4}$ th) of an inch will, of course, represent five hundred (500) yards—or half the distance of the former, in arithmetical progression (or *nearly so*)—and so on for other distances.

And it is not impossible the rifle-sights themselves might be so divided, and used instead of the pencil, but with the radius directed to the front, instead of to the right of the arm.—*August 30th, 1860.*

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SURMISE AS TO THE CAUSE OF DREAMS.

ADDISON somewhere expresses (in the “Spectator,” I think) his opinion that “dreams are our waking thoughts.” I do not know the latest ideas of metaphy-

sicians on the subject—but I wish to set down a few thoughts of my own on this extraordinary occurrence, of dreaming, and one so deserving of investigation.

Most people must have taken notice, some time or other, of the "brain-stone," a peculiar kind of stone, and a beautiful specimen of which is, or was, to be met with at the museum door-way of the Horticultural Society's gardens in the Regent's Park—and so called, I conclude, in consequence of its wonderfully apparent similarity to the superficial configuration or arrangement of the human brain (the skull being removed), in respect of its innumerable lengthy and winding cells, tending in several directions—although together they constitute a generally parallel order.

Now it is, I conceive, in the cells of this parallel arrangement of the human brain that all our thoughts or memories are registered, one after the other, upon a substance quite as sensitive to the reception of impressions, through the operation of the mind, as the photographic (prepared) paper is to receive, and retain, the image of an object thrown on it through the lens by the sun's rays, and thus constituting a "tablet of unutterable thoughts." The almost innumerable lengths and convolutions of these peculiar cells would seem to imply the necessity for such an arrangement, in order to admit of the reception and retention of so many impressions as they must necessarily receive in the course of a longer or shorter life.

I believe our thoughts, therefore, to be *registered* in these cells, as upon the sensorium, quite as surely as that the mind is made acquainted with the existence of an object placed before the sensitive eye—the image being (as it were) photographically brought into mental knowledge by the effect it produces on the *retina* (as elsewhere represented by the photographic paper) and conveyed through, or by means of the optic nerve to the brain, where, again, it is registered—like as the thought is therein also registered.

The thoughts, objects, or images being thus registered in some or other of the cells of the brain, they will continue there in a state of perfect quiescence, unless disturbed by other thoughts, objects, or images, of a similar (or even of a contrary) nature, when they are at times again called forth, as occasion offers or demands—and in what manner and at what periods such disturbance *does* take place, I will endeavour to offer some kind of explanation.

As there is known to exist an intimate connection between the nerves of the stomach and those of the brain, it does not appear difficult to understand that should the nerves of the stomach be affected by any internal cause, the corresponding nerves of the brain will likewise be correspondingly affected—and, indeed, we generally find that if our stomachs be out of order our thoughts are not quite “*so bright*” as they otherwise would be. Now, at night-time, after we have been

indulging in a hearty supper, and have swallowed a *rudis indigestaque moles*," of "stewed lampreys" for instance, which killed one of our early Norman kings, or of cold German sausages and lettuces, which *nearly* killed me a short time since; and after we have "retired for the night" and fallen asleep, and begun to dream a dream—"aye, there's the rub"—exactly so, *there is* the rub, for I maintain that, in consequence of the said *moles* acting by its *vis inertiae* on the organs of digestion, the nerves running through the brain, (as they must necessarily do to enable us to account for the "shooting pain in the head" which frequently occurs) are precluded from obtaining or receiving their usual supply of good healthy blood, or vital action, and consequently an endeavour is made by this circulating blood, or vital action, now stopped in its usual course through each particular cell, (in some cells, probably, more so than in others,) to *force its way*; by which means those impressions which had, during somnolency, been resting, as before observed, in a state of quiescence in their cells, (which cells, I conceive, contain nerves, like any other part of the human frame, but nerves more sensitive and minute,) become now disturbed, are put into a state of activity, and thus produce in the mind the *phenomenon* called dreaming. And, so long as no other portion of the head, brain, body, or frame, is disturbed for the time being by any other cause, so no awakening takes place, until several cells, containing the innumerable ideas or

impressions before registered therein shall have been thus perturbed; and as innumerable ideas are laid up in these minute and continuous cells, (as before explained,) so, innumerable subjects are almost instantaneously brought before us, and made apparent to the *sensorium* or understanding—at any rate, they are brought to our knowledge and recollection, though we be asleep, aye, even in the interval of a second of time, or that occupied by the vibration of one portion of the nerve reaching a contiguous or proximate part of the same series of cellular ramification.

Thus, we can, I trust, without insuperable difficulty of comprehension, understand the cause of a person dreaming continuously almost the whole history of his lifetime; “of hair-breadth escapes by flood and field”—of crossing lofty mountains, precipices, plains, and rivers—of listening to a longer tale than I can here supply—of *recreations* in fishing, shooting, and other *pastimes* (!) and matters—and all of this detail, or even ten times more, occurring within the almost momentary space of time that elapses, say, between the instant a servant first knocks at his master’s bed-room door to awaken him in the morning, and the succeeding instant when he knocks again.—*December 2nd, 1860.*

ACCOUNT OF THE METHOD OF PRODUCING AND PRESERVING ICE IN INDIA.

A FEW days since I was informed by a lady who had but recently returned from Australia that the residents there had (to her knowledge) no means of preserving ice during the hot season of the year, which is intense in that country. So, in order, on her return thither, that she might, by the aid of her friends, endeavour to introduce into the colony that luxury, I set before her, from memory, a description, nearly as follows, of the mode in which it was artificially produced and preserved at the civil and military stations of Allahabad and Cawnpore, in India, many years since; but, assuming the custom to be still adopted there, I shall make use of the present tense in the account.

I.—*Of the Method of Producing the Ice.*

This is effected during, of course, the cold weather, which commences in November and lasts till January inclusive, at no period during which months (including December) do I recollect (and I was a resident of that part of that country—the Duab, a very level portion of India—several years) seeing or hearing of “ice on the ground,” or know of its being found on the surface of ponds or pools of water there; so that artificial means necessarily have to be resorted to for its production. For this purpose an acre (or two) of ground situated at

the most elevated spot obtainable is smoothed, and a good layer of straw strewn upon the surface. Upon this layer of straw an immense number of earthen kiln-burnt saucers or plates of inconsiderable depth and breadth (the size, probably, of a common cheese-plate) are laid in parallel treble or quadruple rows, with sufficient space between each *set* of rows for the coolies, (or native labourers, consisting of men, women, and children,) who lay them, to pass for the purpose, as well as for removing them. These plates are laid on the evening of each day, and removed at day-break, or not long after sunrise every morning. As soon as, or whilst they are being, laid, bheesties (or water-carriers) with mussucks (sheep-skins sewn) filled with water follow the coolies who have laid the plates, and throw into each plate a small quantity of water, sufficient to about half fill it, and as each plate is placed so as to touch its immediate neighbour, so the whole area of the ground is, with exception to the pathways, completely covered with a thin layer (if I may use the term) of water.

The plates, (and the water in them, the former especially,) being somewhat warm at the time of deposit, (the evening,) naturally radiate, during the night-time, a proportionate quantity of heat; and as they are, besides, inconsiderably porous, thereby conducing to additional evaporation, an extraordinary degree of coldness is produced; which, should there be a gentle breeze passing over the spot during the night-time, (and this, especially

towards the morning-dawn, both summer and winter, is frequently the case,) causes the whole upper surface of the water to be congealed to the thickness of a wafer or a shilling-piece. At day-break, or soon after, the coolies are again at work, as fast as they can be employed, removing the earthen plates, throwing away the unfrozen water remaining, as it frequently does, in each plate, and casting the thin stratum of ice contained in them into common wicker baskets brought by other coolies in succession for the purpose of removing it. The ice sometimes adheres to the sides of the vessel in which it has become frozen, but it is easily removed by a slight blow of the stick which the cooly provides. As soon as the basket is filled it is covered with a blanket, and, if I forget not, the basket was lined (at any rate, its sides *ought* to be lined) with flannel or a blanket also—but sufficiently open below for the percolation of the melted ice. It is then taken, and the contents are thrown down into the ice-house—a building I will now proceed to describe—in which it is preserved during nearly the whole four or six months of the hottest season of the year.

II.—*Of the Method of Preserving the Ice.*

A circularly-shaped well, measuring from 24 to 30 feet diameter, is sunken, from the surface of the ground lying adjacent to the field of ice (before described) to a depth of from 12 to 16, or sometimes 20 feet, and in most cases, instead of running perpendicularly down-

wards, the sides are made to slope inwards, so as to retain the shape of a half lemon, for instance, set upside down. The sides of the well are lined with good substantial brick-built masonry, measuring from $1\frac{1}{2}$ to 2 feet thickness, and rest on a firm foundation of the same material, at the centre of which (below) an opening is left for the exit of the melted ice—with a few thick tiles resting on, or rather, over, the aperture, to prevent its being closed up by the ice, or an accumulation of dirt. Below the foundation a smaller well or hole, having its sides also bricked, but the bottom unprotected save by loose rough stones, or gravel, or kunkur, is left, for the reception of this refuse water; and a drain constructed thence—its roof being within a foot of the top of this lower well—in order to carry it off. The circular wall of the main well reaches a foot or two above the ground, and upon this wall rests the roof of the building—the same being composed of common wooden scantling, terminating in about a right angle at the top, where the section of a *circular* king-post suffices. A good thick thatching of straw is laid on this framework, of from $1\frac{1}{2}$ to 2 feet depth, and it reaches almost close “down to the ground.” A few steps are constructed on one side of the (outer) building—that situated furthest away from, or to leeward of, the prevailing wind of the hot season—so as to reach a doorway leading to the upper part of the pit—whence to the bottom, through the ice, a ladder runs down, on which it is afterwards brought up in small

baskets, daily, or less frequently, as may be considered advisable, or called for—the less often the pit being opened, the better for its continuance. The door to be closely fitted into the masonry, and the pit only opened before, or just about the time of sunrise. It should if possible be always in the first instance filled with ice to the brim, during the season of the cold weather—and if it can at once be *built over* circularly with solid masonry (underneath the thatched roof) a round opening having to be afterwards made at the top for removal of the ice, so much the better—as complete exclusion of the hot air will then have been effected, and the ice rendered so much the colder (!), like the Wenham ice, *par exemple* (!), and consequently be the longer capable of preservation in its integrity. When the ice is first cast into the pit it is also rammed well down with wooden rammers or mallets, so as to form a consistent or solid mass. It is afterwards dug out with pickaxes, or mallets and gads. In order to keep off the hot air from the roof, a semi-circularly-shaped bank of earth is thrown up all round the building to nearly half the height of the same, and an opening is left in it for entrance and exit.

A cooly's pay per diem was two annas for a man, one and a half for a woman, and half an anna for a child—the value of an anna being about three half-pence only.

Sometimes ice-houses are constructed of an oval shape as respects the well, the longer axis being the vertical one. An opening through the masonry ceiling 5 or 6

feet broad being left, for entrance to the pit, is covered with a thick, planked door, which is made to rise and fall on hinges fixed at *its* inner or furthest end, at the extremity of a passage cut or left in a *mound of earth*, which mound, instead of the wooden frame and grass roof before detailed, forms the roof or covering of the whole building—and this passage is about 4 feet high by 4 broad, or a little more, and is retained, or revêted with planks fixed behind stanchions, with capsills placed at equal intervals as supports for the same.

Another shaped ice-house is that of a circular hot-water urn, the narrow opening for the lid corresponding with that for the ice-pit. I consider this last kind the best and most economical of any—less masonry being required in the construction of the walls of a globe than of any other figure of corresponding capacity or content. The native ghurrah, or baked earthen pitcher of India, nearly approaches this shape. Whichever form, however, may be adopted, a perforation, or, rather, opening must be left for drainage, as above described.

The cost was about £5 sterling for a single daily share of ice, consisting of 4 seers, or 8 lbs., or £10 for a double one of 16 lbs., so long as it lasted—the same being served out at the pit's-mouth, and conveyed at additional expense, on coolies' heads, or on a banghy or bamboo pole, at each end of which a basket of ice, well protected from the effects of the hot weather by double flannels and casing all round, is suspended on the shoulder; and is

thus carried a considerable distance, without much loss by melting. Butter, otherwise deliquescent, wine, beer (in bottle), cream, water, or jelly, is deposited underneath the ice-flannel, and subsequently placed on the table in a deliciously cool or frozen state—thus constituting one, if not the most desirable, of the far-famed “luxuries of India.” It is consequently worth trying in so hot a country as Australia, where doubtless its gratifying effects would be highly appreciated.—*December 23rd, 1860.*



NOTE “ON THE SPIRAL OF ELECTRICITY.” (p. 30.)

Since the above pages were printed, I find at “p. 111, Proceedings of the Royal Society, No. 43, Vol. XI,” (received 4th April, 1861,) the following remarkable confirmation of the correctness of my opinion as to the spiral or curved direction taken by the magnetic current. “He (Mr. C. V. Walker, F.R.S.) has selected some cases of earth currents, and has set them out in *curves*, and has found a sufficient amount of coincidence to confirm the conclusion that arises, and to encourage further inquiries.”—*London, April 10th, 1861.*

T. S. B.

CRITICAL NOTICES ON THE AUTHOR'S FORMER WORKS.

FROM THE ATLAS, SUNDAY, MAY 7TH, 1837.

Miscellaneous Papers on Scientific Subjects. By T. SEYMOUR BURT, Esq., F.R.S., &c. Vol. I.

"A collection of articles that have been, we believe, all printed in various periodicals. They relate, as the title imports, to scientific subjects, and discover in the author not merely considerable talent, but a diversity of studies that are highly creditable to him. It is peculiarly gratifying to recognise the ability that is daily showing itself in the Indian service."

FROM THE ASIATIC JOURNAL FOR 1837.

"*Tam Marte quam Mercurio* may be Major Burt's motto. To his professional pursuits he unites a taste for literary antiquities and for scientific inquiries; in the latter he has developed some new and ingenious theories in the papers included in this collection."

FROM THE TIMES, APRIL 8TH, 1837.

"Major Burt, late of the Spanish service (Captain B.E.), has just printed a collection of *Miscellaneous Papers on Scientific Subjects*, chiefly written in India, and which have appeared in various periodical works. They treat of a diversity of subjects, and possess considerable merit. * * * * Whilst upon the subject of Indian antiquities, we may notice the sudden impulse which has been recently given to their study, and the valuable results which have attended it."

FROM THE CRITIC, JULY 17TH, 1858.

Miscellaneous Papers on Scientific Subjects, written chiefly in India. By Major T. S. BURT, F.R.S. Vol. II.

"The first volume of this selection from Major Burt's portfolio appeared in 1837, exactly twenty-one years ago; and in this long interval the gallant and ingenious author has accumulated material enough to fill a thin volume of 148 pages duodecimo. Would that all authors were as modest. The first

papers *de omni rescibile*, which he had brought together from various sources. The little volume before us was originally printed more than twenty years ago, and he now reprints it, partly because it originally appeared in a very imperfect condition, and partly because, in his opinion, it contains "many circumstances worthy the attention of persons proceeding to India." Although in this age of rapid progress most of the facts of this journey twenty years ago are nearly as much out of date as Horace's journey to Brundisium, it is not to be denied that it is pleasantly written, and contains much that may be of service to the modern traveller."

FROM THE ILLUSTRATED NEWS OF THE WORLD,

APRIL 2ND, 1859.

Account of a Voyage to India, viâ the Mediterranean. By T.
SEYMOUR BURT, Esq., F.R.S.

"Although the voyage here chronicled was performed twenty years ago, the work will be found to contain a vast amount of matter most valuable to travellers to India in the present day. The incidents of the voyage are recounted in a pleasant, chatty style. The descriptions are unusually good; and the whole is imbued with a light, genial, and gentlemanly humour, which makes it very pleasant reading."







